GRADE 12
DIPLOMA EXAMINATION

Chemistry 30

June 1986

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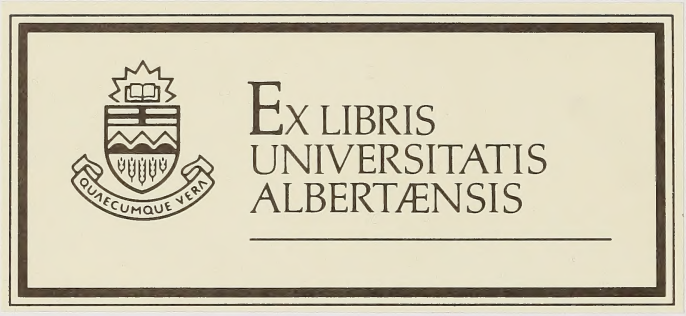

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GRADE 12 DIPLOMA EXAMINATION
CHEMISTRY 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Three written-response questions for a total of 14 marks.

A chemistry data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. USE AN HB PENCIL ONLY.

Example	**Answer Sheet**
This examination is for the subject area of	A B C D
A. Chemistry	● ② ③ ④
B. Biology	
C. Physics	
D. Mathematics	

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JUNE 1986

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PART A

INSTRUCTIONS

There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

1. The kinetic energy of a molecule is a combination of

A. bond energy and electron motion
B. nuclear energy and molecular motion
C. molecular motion and electron motion
D. bond energy, force within the nucleus, and forces between the nucleus and electrons

2. 1.0 g of steam at 100°C possesses more energy than 1.0 g of water at 100°C because the

A. potential energy is greater in the steam
B. molecules in the steam have greater bonding energy
C. potential energy and the kinetic energy are equal in the steam
D. attractive forces between the molecules are greater in the steam

3. According to the equation $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g) + 184$ kJ, ΔH per mole of HCl(g) is

A. +184 kJ
B. +92 kJ
C. −92 kJ
D. −184 kJ

4. The standard enthalpy of formation of a compound is the enthalpy change for the reaction in which one mole of the compound

A. is made from its elements in their standard states
B. forms its component elements in their standard states
C. forms from reacting compounds in their standard states
D. is made from its elements at any temperature and pressure

5. When elements combine to form a compound, the net energy is always

A. absorbed
B. lost to the environment
C. either absorbed or released
D. gained from the environment

6. A suitable hypothesis for an experiment related to energy is that an endothermic change can be defined as one in which

A. the temperature of the surroundings decreases
B. a spontaneous process tends toward a state of lower energy
C. less energy is involved in breaking bonds than in bond formation
D. energy is transferred from the reacting system to its surroundings

7. The equation which represents an exothermic process is

A. $CoF_2(s) \longrightarrow CoF_2(l)$ $\Delta H = +77.8$ kJ

B. $6C(s) + 3H_2(g) + 82.9\ kJ \longrightarrow C_6H_6(l)$

C. $2Na(s) + \frac{1}{8}S_8(s) + 2O_2(g) \longrightarrow Na_2SO_4(s)$ $\Delta H = -1381.5$ kJ

D. $KOH(s) + 425.8\ kJ \longrightarrow K(s) + \frac{1}{2}O_2(g) + \frac{1}{2}H_2(g)$

Use the following information to answer question 8.

1. $4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3(s) + energy_1$

2. $I_2(g) \longrightarrow I_2(s) + energy_2$

3. $^{238}_{92}U \longrightarrow {}^{4}_{2}He + {}^{234}_{90}Th + energy_3$

8. The best prediction regarding the energies of the above reactions is

A. $energy_1$ is less than $energy_2$
B. $energy_2$ is greater than $energy_3$
C. $energy_3$ is greater than $energy_1$
D. $energy_3$ is less than either $energy_1$ or $energy_2$

9. Ethyne (acetylene) is completely burned to yield gaseous products. The heat of combustion of ethyne is

A. −2511.0 kJ/mol
B. −1255.5 kJ/mol
C. −1028.8 kJ/mol
D. −862.0 kJ/mol

10. When $C_9H_{18}(l)$ burns according to

$C_9H_{18}(l) + \frac{27}{2} O_2(g) \longrightarrow 9CO_2(g) + 9H_2O(g)$, $\Delta H = -5615$ kJ. The heat of formation for C_9H_{18} (l) is

A. -103 kJ/mol
B. -500 kJ/mol
C. -3542 kJ/mol
D. -5718 kJ/mol

11. The potential energy of the product(s) is less than the potential energy of the reactant(s) for

A. $H_2O(g) \longrightarrow H_2(g) + \frac{1}{2}O_2(g)$

B. $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$

C. $\frac{1}{2}H_2(g) + \frac{1}{2}I_2(s) \longrightarrow HI(g)$

D. $\frac{1}{2}N_2(g) + O_2(g) \longrightarrow NO_2(g)$

12. A student burns 1.00 g of anthracite coal and finds it releases enough energy to raise the temperature of 7.30×10^2 mL of water 10.0°C. Using this data, the student should predict that the heat released by 2.00 g of coal would be

A. 15.3 kJ
B. 30.6 kJ
C. 61.2 kJ
D. 6120 kJ

13. A student designs an experiment to measure the heat of combustion of benzene. The student completely burns 1.20 g of benzene which produces gaseous products and causes 4.50 L of water in a calorimeter to rise in temperature from 21.05°C to 23.58°C. Using these data, the calculated value for the heat of combustion of benzene would be

A. -4.33 MJ/mol
B. -3.11 MJ/mol
C. -2.71 MJ/mol
D. -1.88 MJ/mol

14. When a charcoal (carbon) briquette burns completely in air to form carbon dioxide, energy is released. This energy, when used as one of the variables of an experiment, could be labelled as the heat of

A. formation of carbon
B. vaporization of carbon
C. formation of carbon dioxide
D. combustion of carbon dioxide

15. The ΔH value for the reaction $2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$ is

A. -566 kJ
B. -283 kJ
C. $+283$ kJ
D. $+566$ kJ

Use the following information to answer question 16.

$$88 \text{ kJ} + C(s) + \tfrac{1}{4}S_8(s) \longrightarrow CS_2(l)$$

16. For the reaction $CS_2(l) + 3O_2(g) \longrightarrow CO_2(g) + 2SO_2(g)$, ΔH is

A. -7.81×10^2 kJ
B. -9.91×10^2 kJ
C. -1.08×10^3 kJ
D. -1.47×10^3 kJ

Use the following information to answer question 17.

$$U(s) + O_2(g) \longrightarrow UO_2(s) \qquad \Delta H = -1130.0 \text{ kJ}$$

$$2UO_3(s) \longrightarrow 2UO_2(s) + O_2(g) \qquad \Delta H = +260.0 \text{ kJ}$$

17. The heat of reaction for $2U(s) + 3O_2(g) \longrightarrow 2UO_3(s)$ is

A. -260.0 kJ
B. -870.0 kJ
C. -2000.0 kJ
D. -2520.0 kJ

---

18. For the reaction $C(s) + \frac{1}{2}O_2(g) \longrightarrow CO(g) + 111$ kJ, the most accurate description of the energy involved is that

A. the reaction is endothermic
B. 111 kJ of heat are required to burn one mole of carbon
C. the combustion of 12.0 g of carbon releases 111 kJ of heat
D. 111 kJ of heat are released when one mole of oxygen is consumed

19. The property that is characteristic to all aqueous acids as they dissolve is the

A. decrease in electrical conductivity
B. change in litmus color from red to blue
C. increase in the hydroxide ion concentration
D. increase in the hydronium ion concentration

20. When hydronium ions react with hydroxide ions, the process is known as

A. titration
B. hydration
C. dissociation
D. neutralization

21. A student should predict that adding NaOH(s) to an acetic acid solution would increase

A. the number of water molecules present
B. the hydronium ion concentration of the solution
C. none of the equilibrium concentrations of the solution
D. the concentration of the acid molecules in the solution

22. A student added the acid HA to water, and hypothesized that 95 out of 100 molecules formed ions. At equilibrium, if the hypotheses were correct, this solution would have

A. relatively few $A^-(aq)$ ions
B. relatively few $H_3O^+(aq)$ ions
C. the properties of a strong acid
D. a large concentration of reactants

23. According to the Brønsted-Lowry definition, a base is

A. a proton donor
B. a proton acceptor
C. an electron donor
D. an electron acceptor

24. For the weak acid HX(aq), the hydronium ion concentration is

A. equal to [HX(aq)]
B. less than [X^-(aq)]
C. less than [HX(aq)]
D. greater than [X^-(aq)]

Use the following information to answer question 25.

$$HSO_4^-(aq) + HCO_3^-(aq) \leftrightharpoons H_2CO_3(aq) + SO_4^{2-}(aq)$$

25. Which of the following statements is INCORRECT?

A. The reaction is reversible.
B. The reaction favors reactants.
C. $HCO_3^-(aq)$ is a stronger base than $SO_4^{2-}(aq)$.
D. $HSO_4^-(aq)$ is a stronger acid than $H_2CO_3(aq)$.

---

26. A student considering aqueous solutions of sugar, ammonia, silver chloride, and hydrogen chloride should predict that the best conductor of electricity would be

A. sugar
B. ammonia
C. silver chloride
D. hydrogen chloride

Use the following information to answer question 27.

A student added 0.60 g of NaOH(s) to 100 mL of 0.20 mol/L HCl(aq), and then measured the pH of this initial solution. Next, water was added to bring the final volume to 10.0 L, and the pH of this final solution was measured. The pH measurements were recorded.

27. Which of the following would be a correct statement about the student's data?

A. The pH of the final solution is 7.
B. The pH of the final solution is equal to the pH of the initial solution.
C. The pH of the final solution is less than the pH of the initial solution.
D. The pH of the final solution is greater than the pH of the initial solution.

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28. The pH of a 0.05 mol/L $Sr(OH)_2(aq)$ solution is

A. 1.0
B. 1.3
C. 12.7
D. 13.0

29. A solution of NaOH(aq) has a pH of 10.0. The $[H_3O^+(aq)]$ of this solution is

A. 1.0×10^{15} mol/L
B. 1.0×10^{1} mol/L
C. 1.0×10^{-4} mol/L
D. 1.0×10^{-10} mol/L

30. A student prepared a mixture by combining equal volumes of the indicators orange IV, bromothymol blue, and thymolphthalein. If a drop of this mixture was to be added to a solution with a pH of 6.0, the student should predict the color to be

A. red
B. blue
C. green
D. yellow

31. The conjugate base of $H_2BO_3^-(aq)$ is

A. $OH^-(aq)$
B. $BO_3^{3-}(aq)$
C. $HBO_3^{2-}(aq)$
D. $H_3BO_3(aq)$

Use the following information to answer question 32.

The following data were obtained while a student standardized aqueous KOH by titrating aqueous $KHC_8H_4O_4$.

Mass of erlenmeyer flask + $KHC_8H_4O_4(s)$	97.79 g
Mass of erlenmeyer flask	96.77 g
Volume of distilled water	50.0 mL
Final buret reading for base	30.0 mL
Initial buret reading for base	5.0 mL

The student calculated the molar mass of $KHC_8H_4O_4$ to be 204.23 g/mol and assumed that it is a monoprotic acid.

32. The student's calculated value for the concentration of the aqueous KOH should be

A. 6.72×10^{-3} mol/L
B. 6.72×10^{-2} mol/L
C. 1.00×10^{-1} mol/L
D. 2.00×10^{-1} mol/L

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33. A correct prediction of what happens when colorless phenolphthalein is placed in a solution of potassium phosphate is that

A. no reaction takes place and the solution remains colorless
B. phenolphthalein molecules lose protons and the solution turns pink
C. potassium ions react with the phenolphthalein and the solution turns pink
D. phenolphthalein molecules lose protons and the solution remains colorless

34. The $[OH^-(aq)]$ in a 1.0×10^1 mol/L HCl solution is

A. 1.0×10^{-12} mol/L
B. 1.0×10^{-13} mol/L
C. 1.0×10^{-14} mol/L
D. 1.0×10^{-15} mol/L

35. A student dissolves 4.0 g of NaOH(s) to make 1.0 L of NaOH solution and then predicts the $[H_3O^+(aq)]$ of the solution. The best prediction is

A. 1.0×10^{-14} mol/L
B. 1.0×10^{-13} mol/L
C. 1.0×10^{-7} mol/L
D. 1.0×10^{-1} mol/L

36. When a number of moles of $C_6H_5COOH(aq)$ is titrated with an equal number of moles of NaOH(aq), the solution is said to be at the

A. critical point
B. titration point
C. indicator point
D. equivalence point

37. The mass of $Ba(OH)_2(s)$ required to react completely with 150 mL of 0.40 mol/L HF(aq) would be

A. 0.60 g
B. 1.2 g
C. 5.1 g
D. 10 g

38. Which of the following is oxidized in the reaction
$4HNO_3(aq) + Sn(s) \longrightarrow SnO_2(s) + 4NO_2(g) + 2H_2O(l)$?

A. H
B. N
C. O
D. Sn

39. In an oxidation-reduction reaction electrons are

A. lost by the oxidizing agent
B. gained by the reducing agent
C. gained by the oxidizing agent
D. transferred from the oxidizing agent to the reducing agent

40. In a redox reaction the reducing agent

A. undergoes a decrease in oxidation number
B. causes oxidation to occur
C. gains electrons
D. is oxidized

Use the following information to answer question 41.

A student observes that a red-brown color results when 1.0 mL of freshly prepared chlorine water is added to 5.0 mL of 0.1 mol/L KBr solution.

41. The student should interpret that the substance oxidized is

A. $Br^-(aq)$
B. $Br_2(l)$
C. $K^+(aq)$
D. $Cl_2(g)$

---

42. The equation that correctly represents the reaction most likely to occur when aqueous solutions of iron (III) nitrate and tin (II) nitrate are mixed is

A. $2Fe^{3+}(aq) + H_2O(l) \longrightarrow 2H^+(aq) + \frac{1}{2}O_2(g)$

B. $2Fe^{3+}(aq) + 3Sn^{2+}(aq) \longrightarrow 2Fe(s) + 3Sn^{4+}(aq)$

C. $2Fe^{3+}(aq) + Sn^{2+}(aq) \longrightarrow 2Fe^{2+}(aq) + Sn^{4+}(aq)$

D. $3Sn^{2+}(aq) + 2NO_3^-(aq) + 8H^+(aq) \longrightarrow 2NO(g) + 2H_2O(l)$

43. If the oxidation number of an element changes from $+4$ to -2, the element

A. was oxidized
B. gained electrons
C. acted as a reducing agent
D. increased its oxidation state

Use the following information to answer question 44.

A student determined that for an oxidation-reduction reaction the reactants, $MnO_4^-(aq) + Cu(s)$ and their products $Mn^{2+}(aq) + Cu^{2+}(aq)$, are all in an acidic solution. The student then completed and balanced the equation.

44. The sum of all coefficients when the equation is completed and balanced is

A. 14
B. 16
C. 18
D. 38

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45. The concentration of bromide ions in a sample of sea water is 1.50×10^{-4} mol/L. The mass of chlorine gas needed to oxidize the bromide ions in 2000 L of sea water is

A. 42.6 g
B. 21.3 g
C. 10.7 g
D. 5.33 g

46. The oxidizing agent in a mixture of anions and cations would

A. gain electrons and have the largest oxidation potential
B. gain electrons and have the largest reduction potential
C. lose electrons and have the largest oxidation potential
D. lose electrons and have the largest reduction potential

47. A student constructed an electrochemical cell using a $Be(s)/Be^{2+}(aq)$ anode and an $H_2(g)/H^+(aq)$ cathode, and recorded an E°_{net} value of 1.70 V. The student then constructed a second cell using $Be(s)/Be^{2+}(aq)$ and $Au(s)/Au^{3+}(aq)$. The predicted cathode half-reaction for the second cell should be

A. $Au(s) \longrightarrow Au^{3+}(aq) + 3e^-$

B. $Au^{3+}(aq) + 3e^- \longrightarrow Au(s)$

C. $Be(s) \longrightarrow Be^{2+}(aq) + 2e^-$

D. $Be^{2+}(aq) + 2e^- \longrightarrow Be(s)$

Use the following information to answer question 48.

A student placed single drops of $Cd(NO_3)_2(aq)$, $Hg(NO_3)_2(aq)$, and $Pt(NO_3)_2(aq)$ separately on a Cr metal strip. A spontaneous reaction was observed for each drop. In a similar test, the student observed that $Pt(NO_3)_2(aq)$ reacted spontaneously with Hg metal, but $Cd(NO_3)_2(aq)$ and $Cr(NO_3)_2(aq)$ did not. The student then presented the collected data to show the relative strength of the oxidizing agents.

48. In decreasing order of strength, the student's list of oxidizing agents should be

A. $Pt^{2+}(aq)$, $Hg^{2+}(aq)$, $Cd^{2+}(aq)$, $Cr^{2+}(aq)$

B. $Pt^{2+}(aq)$, $Hg^{2+}(aq)$, $Cr^{2+}(aq)$, $Cd^{2+}(aq)$

C. $Cd^{2+}(aq)$, $Hg^{2+}(aq)$, $Pt^{2+}(aq)$, $Cr^{2+}(aq)$

D. $Cd^{2+}(aq)$, $Cr^{2+}(aq)$, $Hg^{2+}(aq)$, $Pt^{2+}(aq)$

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49. Consider the half-reaction and electrode potential $Sn^{2+}(aq) + 2e^- \longrightarrow Sn(s)$ $E° = -0.14$ V. The oxidation half-reaction and half-cell potential are

A. $Sn(s) \longrightarrow Sn^{2+}(aq) + 2e^-$ $\quad E° = -0.14$ V

B. $Sn(s) \longrightarrow Sn^{2+}(aq) + 2e^-$ $\quad E° = +0.14$ V

C. $Sn^{2+}(aq) \longrightarrow Sn^{4+}(aq) + 2e^-$ $\quad E° = -0.15$ V

D. $Sn^{2+}(aq) \longrightarrow Sn^{4+}(aq) + 2e^-$ $\quad E° = +0.15$ V

50. The substance that is most likely to act as a reducing agent in a redox reaction is

A. $Fe^{2+}(aq)$
B. $Cr^{3+}(aq)$
C. $Sn^{4+}(aq)$
D. $Hg_2^{2+}(aq)$

51. The largest voltage will be produced by the reaction between

A. $Hg^{2+}(aq)$ and $Br_2(l)$
B. $Hg^{2+}(aq)$ and Sn(s)
C. $Br_2(l)$ and $Hg(l)$
D. $Br_2(l)$ and Sn(s)

52. A reaction that may be predicted to produce electrical energy by oxidation-reduction is

A. $2NaOH(aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$

B. $2CrO_4^{2-}(aq) + 2H^+(aq) \longrightarrow Cr_2O_7^{2-}(aq) + H_2O(l)$

C. $AgNO_3(aq) + HCl(aq) \longrightarrow AgCl(s) + HNO_3(aq)$

D. $Mg(s) + Cl_2(g) \longrightarrow 2\ Mg^{2+}(aq) + 2Cl^-(aq)$

53. Strips of copper, zinc, and silver are placed in a beaker containing an aqueous solution of 1.0 mol/L copper (II) sulphate. The chemical species which will undergo oxidation is

A. Ag(s)
B. Cu(s)
C. Zn(s)
D. $Cu^{2+}(aq)$

54. In an electrochemical cell, the number of electrons gained must always equal the number of electrons

A. gained by the reducing agent
B. lost by the oxidizing agent
C. lost during reduction
D. lost during oxidation

55. During the electrolysis of molten NaCl, the product(s) formed at the cathode is/are

A. Na(*l*)
B. $Cl_2(g)$
C. $H_2O(l)$
D. $H_2(g)$ and $O_2(g)$

56. A current of 10.0 A is passed through $AuCl_3(aq)$ for 2.00 h. The mass of Au(s) deposited is

A. 49.0 g
B. 75.3 g
C. 88.0 g
D. 147.0 g

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

TOTAL MARKS: 14

START PART B IMMEDIATELY

Use the following information to answer question 1.

A student has decided to determine the quantity of heat required to ''warm-up'' his car engine on a cold winter morning. He has been able to approximate an average specific heat for the whole engine and has a table of ΔH values for pure compounds. He is going to use pure octane in the fuel tank and his car has a Celsius scale on the heat gauge.

(5 marks) 1. a. In one or two brief statements describe one general method the student could use to determine the quantity of heat. (There are at least two.)

_____

_____

b. For the method indicated in question 1 a.:

(i) State one major assumption the student would have to make.

_____

(ii) Indicate one variable that would have to be measured.

_____

(iii) State one major calculation the student would have to use in processing the data.

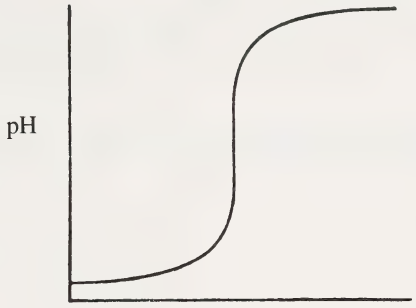
_____

(iv) Where would a major source of error occur?

_____

Use the following information to answer question 2.

This curve is the result of the data obtained from a titration process using an acid and a base.



(5 marks) 2. a. Is the sample being added to an acid or to a base? _____

Explain how you know. _____

_____

_____

b. Explain why the slope of the curve is so gradual at the beginning of the titration.

_____

c. Explain the vertical portion of the curve.

_____

_____

_____

d. Choose a suitable substance that you could use as the sample to be added to give these results. What properties does this substance have in order to give these results?

_____; _____

_____

_____

Use the following information to answer question 3.

A student is planning to construct an electrochemical cell which will be used to operate a motor that requires at least 1.96 V. The following materials were supplied for construction of the cell.

Metal strips of Ni(s), Al(s), and Ag(s)

1.0 mol/L solutions of $Ni(NO_3)_2$, $Al(NO_3)_3$ and $AgNO_3$

(4 marks) 3. a. Write the net equation for the reaction which could be used to provide the energy to operate the motor.

b. What mass of the anode selected would be oxidized during the production of 2.43 mol electrons?

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

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